How to interpret an ancient landscape

Vernon L. Scarborough*

Department of Anthropology, University of Cincinnati, Cincinnati, OH, 45221-0380

Perhaps as a foil to postmodern anthropology and geography, a seemingly increased percentage of publications examining material-grounded human ecological relationships have championed a highly deterministic view of the environment (1, 2). Rather than evolving with newly accessed data and methods for their retrieval, several pioneers of human ecology and their students continue to argue for an altered biophysical environment without assessing the changes, sometimes subtle, in societal structures (3, 4). The article by Fisher *et al.* (5) in this issue of PNAS takes on that tired perspective of human ecology and implicitly demonstrates the necessity of economy: how humans make a living and structure their activities to achieve that living (6). Although the report focuses on a relatively small ancient west-Mexican society, it sets the stage for deconstructing the determinism of human ecology, the view that human society both impacts and is impacted by the environment based on the same suite of physical forces that dictate changes in the natural world, a biophysical environment less subject to the different socioeconomic and sociopolitical organizational strategies practiced by humans. Although the biophysical environment remains fundamental, it is necessarily contextualized by culture.

The legacy of human ecology in anthropological circles is anchored in J. H. Steward's (7) classic study of the Paiute of the western Great Basin in North America. Steward's careful assessment of subsistence practices and their linkages to the environment firmly established "cultural ecology" as the appropriate path for anthropologists wedded to the material underpinnings of society, principally those scholars emphasizing technology and aspects of the economy (8). Archaeologists rapidly accepted this orientation (9). Although Steward's theoretical approach can be credited with the high quality of data retrieval customary in archaeological studies, the approach fits best with evaluations of ancient hunting and gathering lifeways, those ancient groups whose impact on the landscape was much less severe than that of more socially complex societies. Nevertheless, Steward attempted to adapt this version of human ecology to explain the complex social organization of the archaic state through the use of Karl Wittfogel's theory of statecraft (the art of conducting state affairs) based on the primacy of water management and the power imparted to those who controlled water allocation, especially in semiarid settings (10, 11). Cultural ecology as practiced by many archaeologists remains in the shadows of Steward. Although stridently opposed to Wittfogel's specific determinism as an explanation for the origins of social complexity, several scholars implicitly embrace the "man-land" directives of both thinkers (12, 13).

Fig. 1. The engineered landscape of Bali, Indonesia.

Recent ethnographic and ethnohistoric work by Lansing (14) and others (15, 16) shows us that sedentary populations, especially those with a prehistory/history of statecraft, concentrate resources based on complicated and frequently subtle interactions and interdependencies both within and between communities and with their immediate environs. Because humans have significantly influenced natural ecological relationships for a very long time, notions of "pristine" or untouched settings are seldom an acceptable baseline for evaluation of any environment (17, 18). In the case of sedentists, tremendous landscape engineering has produced a world of built environments, perhaps most visible in urban relief but no less significant and enduring across a vast temporal and spatial landscape of agricultural activity. Any built environment is incrementally altered year after year, generation after generation. Built environments sometimes collapse in moments of severe degradation induced by the many possible geomorphological and climatic forces, but they are frequently sustained by a set of traditional resource allocation and maintenance formulas (the structured manner by which work activity is conducted) established and reestablished generationally by the residing group (19).

For example, the spectacular hillside rice terraces and paddy field terrain of Bali, Indonesia, evolved in concert with the island's socioeconomic and sociopolitical organization (20). Fig. 1 captures the degree of construction and maintenance effort invested in the landscape by this long-lived society. Sophisticated statecraft based on resource concentrations and labor centralization was relocated from neighboring Java by at least the 11th century. Nevertheless, the material signs of centralized state control were poorly manifest on Bali, although social complexity was reflected in an early and highly successful adaptation to an ecologically constraining environment. The institution of geographically dispersed water temples, together with

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*E-mail: vernon.scarborough@uc.edu.

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the priests and functionaries that maintained them and allocated the water resource, was the material manifestation of a heightened social complexity. The Balinese landscape was accretionally altered, reflecting a self-organizational process that continues today (14). The high population densities of the island are sustained by labor routines and activities that residents established and reinforced based on their deep understanding of Balinese (human) ecology. Attempts to significantly change the production strategies of the rice paddy system have exacted a high economic and political price (14, 21).

Our recent work in northwestern Belize (22–24) strongly supports the interpretations that Fisher *et al.* (5) present. Although from a nearby and ecologically dissimilar region of Mesoamerica, the ancient Maya appear to have degraded their shallow wetlands by the Late Preclassic period (400 B.C.–A.D. 100) in a manner not unlike that around Lake Pátzcuaro. We attribute that degradation or sedimentation to increased population growth, spurred by increased residential clearing and agricultural field use (22, 25, 26). However, rather than social collapse, the subsequent bearers of Maya tradition reinvented themselves by relocating to the summits of the many hills and ridges overlooking the sizable infilling wetlands, which remain as seasonally inundated swamps (27). Through a series of clever landscaping alterations, the Maya constructed an urban environment of elevated reservoirs and paved catchments that secured the seasonal tropical rainfall runoff and allowed year-round water access away from the silted-in swamp depressions (28). These Classic period Maya (A.D. 200–900) introduced formalized writing, fancy polychrome pottery, stela monuments, and grand palaces, all trappings of a newly defined/refined notion of kingship. Such dramatic changes in the material record reflect significant structural changes in society. As in the Balinese example, material changes among the Classic period Maya reveal fundamental modifications in the socioeconomic and sociopolitical underpinnings of culture, a culture inextricably linked to its environment.

Subsequent social collapse in parts of the Maya area by A.D. 900 was not induced by European advance, but rather by a complicated set of indigenous cultural decisions. These decisions were based on labor routines that could no longer be sustained by an environment that had been accretionally altered for >800 years (29). Although a naturally fragile semitropical environment, the setting had been incrementally improved during the Classic period florescence, producing an engineered landscape far more accepting of human exploitation than that identified in the earlier Late Preclassic. Nevertheless, unaltered population growth (30) coupled with climatic change (31–33) eventually resulted in cultural calamity. The significantly modified environment the Maya had built for themselves was still conditioned by the environmental constraints of a wet–dry tropical forest. Although considerable energy and time are invested in modeling the ancient Maya Collapse, much more attention is required to elucidate the superbly successful tropical environmental adaptations made by the Maya over a period of 1,500 years (29).

Dense populations are not an explanation for overexploitation of an environment.

The two cases presented, one ethnographic and the other archaeological, illustrate the connection that human ecology has to the economy and the context for interpreting Fisher *et al.*'s report (5). The basic premise of their skillfully presented paper is that increasingly dense populations are not an explanation for overexploitation of an environment. Although postmodernism continues to argue for the primacy of ideology as the triggering mechanism for complexity and change (34), another set of scholarly perspectives understands the life-altering effects of population pressure. But the latter group has been guided by an underdeveloped view of what societies do. Fisher and his team (5) show that sizable populations frequently intensify over a landscape and accretionally alter their carrying capacity. Enduring complex societies are especially creative over the *longue durée* in engineering the landscape that accommodates their developing material needs. The socioeconomic and sociopolitical organization of early complex societies evolves with their altered landforms (19). Although populations can overshoot their resource base, Geertz's involution (35), societal collapse, is seldom explained so simply. Just look at the enduring tide of humanity successfully operating within the skill-oriented economies of East Asia, even Indonesia (14, 15).

In the case of ancient Michoacán, we see an enduring set of structured activities on the landscape that sustained and maintained the ancient economy. Disruption of the dynamic interplay between the engineered landscape and the complex society that built it was a disruption of the economy and of work, the routine maintenance activities structuring labor. Because biophysical environmental collapse correlates with the onslaught of Spanish colonization, disease as well as European technologies and definitions of work, or the structure of routine activity, regional degradation at both the environmental and the societal levels occurred. As Fisher *et al.* (5) indicate, conventional wisdom suggests that these "primitives" overtaxed their resource base. Given the data they present herein, we have a clearer assessment of causality based on convincing ecological parameters placed in meaningful societal context, a causality positioned to challenge past definitions of human ecology.

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